Comment Resolution for High-Priority Topics

Howard Heck, Intel

TX V_CMPP/SCMR
Summary

C#	Description	CL/AN
29	Reduce $V_{CMPP\text{-}LF}$ value	162, 163, 120F, 120G
1,4	Remove SCMR dependence on Tx equalization	163
35	Replace $V_{CMPP\text{-}HF}$ with SCMR	162, 120G
42	Reinstitute ‘all frequency’ ACCM RMS spec	162, 120G
53	Change ACCM pk-pk measurement filter	163, 163, 120F, 120G

TX V_CMPP/SCMR Comment 29

Cl **162** *SC* **162.9.3** *P* **166** *L* **30** **#** R1-29

Ran, Adee Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX V_CMPP/SCMR (CC)*

(Cross-clause - 162, 163, 120F, 120G)

VCMPP-LF max value of 60 has no justification. In the presentations mellitz_3ck_01_0122 and mellitz_3ck_02_0122 the suggested limits were 30 mVpp and 40 mVpp for low frequency respectively. mellitz_3ck_adhoc_01_011222 slide 3 shows power supply noise distributions that are mostly below 40 mVpp and the best cases are about 25 mVpp. 60 mVpp was chosen as a result of a straw poll with no data or recorded reason.

We previously had a limit of 25 mV RMS without filtering (including the more significant high-frequency noise). Assuming HF and LF components are independent, the RMS should be the RSS of the RMSs of these components. Assuming uniform distribution of LF noise, 60 mVpp means 17 mV RMS for this component, leaving just 18 mV RMS for the HF component – and we struggled to increase the CM RMS to 25-30 mV mainly because of the HF component! The LF component was supposed to be much lower than that.

Assuming LF CM noise results from power supply noises (the only source that was discussed), a 60 mVpp for all but 1e-4 (which excludes rare events like powering other circuits on or off) would be a very sloppy design which would likely result in other impairments such as excessive jitter.

The LF CM component is not filtered out by the channel so we can expect the same levels at the receiver. The effect of LF CM noise on receivers depends on design, but in general, low-frequency effects may cause periods of higher-than-average BER and result in unexpected FEC failures which will be difficult to debug. We should avoid that by limiting the transmitter's CM noise (much easier to verify).

Same reasoning applies to 163.9.2, 120F.3.1, and 120G.3.1. For AUIs the VCMPP is defined at 1e-5 and the allowed range should be somewhat higher. Scaling by the Q value, the limit should be 13% higher, but I assume LF CM is closer to uniform than to Gaussian so the proposal for AUIs is just 7% higher.

SuggestedRemedy

In 162.9.3 and 163.9.2, change the VCMPP maximum from 60 mV to 30 mV.
In 120F.3.1 and 120G.3.1, change the VCMPP maximum from 60 mV to 32 mV.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
Note: This comment pertains specifically to V_CMPP_LF.
For task force discussion.
[Editor's note: CC 120F, 120G, 163]

D3.1, Table 162-10, pp. 166

AC common-mode peak-to-peak voltage (max) Low frequency, $V_{CMPP\text{-}LF}$ High frequency, $V_{CMPP\text{-}HF}$	163.9.2.7	 60 80	 mV mV

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D3.1, Table 163-5, pp. 203

Low-frequency peak-to-peak AC common-mode voltage, $V_{CMPP\text{-}LF}$ (max)	163.9.2.7	60	mV

D3.1, p, 239 Table 120F-1

Low-frequency peak-to-peak AC common-mode voltage, $V_{CMPP\text{-}LF}$ (max)	120F.3.1.1	60	mV

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D3.1, Table 120G-1, p. 258

Peak-to-peak AC common-mode voltage (max) Low-frequency, $V_{CMPP\text{-}LF}$ High-frequency, $V_{CMPP\text{-}HF}$	120G.5.1	 60 80	mV

D3.1, Table 120G-3, p. 261

Peak-to-peak AC common-mode voltage (max) Low-frequency, $V_{CMPP\text{-}LF}$ High-frequency, $V_{CMPP\text{-}HF}$	120G.5.1	 60 80	mV

TX V_CMPP/SCMR Comment 1

Cl 163	SC 163.9.2.8	P 207	L 18	# R1-1

Ran, Adee — Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX V_CMPP/SCMR (CC)*

Following ad hoc presentation ran_3ck_01_032322, it is suggested to provide more specific definitions or guidance for Tx parameters that depend on equalization, to enable reasonable test times, both for design (simulations) and qualification (with instruments).

SCMR is currently defined without reference to equalization setting. The numerator of the SCMR ratio is strongly dependent on equalization setting, while the denominator is mostly independent. So measurements with different equalization will yield different results.

The proposal is to define SCMR with respect to the unequalized pulse peak.

If we have a formal definition of v_peak in 162.9.4.1.2 (subject of another comment), SCMR can just refer to that subclause.

SuggestedRemedy

Delete the sentence "The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response p(k)." from the first paragraph.

Change the definition of SCMR to be
SCMR=20*log10(v_peak/V_{CMPP-HF})

In the "Where" list:
v_peak is the is the maximum value of the differential-mode linear fit pulse response p(k), determined using the procedure in 162.9.4.1.1 with equalization off.
- or -
v_peak is defined in 162.9.4.1.2.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The following related presentation was reviewed at a previous task force meeting:
https://www.ieee802.org/3/ck/public/adhoc/mar23_22/ran_3ck_adhoc_01_032322.pdf
This comment does not provide sufficient evidence that v_peak should be used.
For task force discussion.
[Editor's note: CC: 162, 163, 120F]

SCMR

- The SCMR definition says "The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response p(k)."
  - The numerator p_{max} is defined as the maximum of p(k), which clearly depends on equalization.
  - The denominator, $V_{CMPP-HF}$ is mostly independent of equalization setting.
  - ⇒ SCMR strongly depends on equalization setting – and unspecified equalization is a problem for testing and validation.
- How about: Change the equation to use v_{peak} instead of p_{max}, where v_{peak} is defined with equalization off.
  - This will remove the dependence on equalization setting.

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ran_3ck_adhoc_01_032322

163.9.2.8 Signal to AC common-mode noise ratio

Signal to AC common-mode noise ratio, *SCMR*, is calculated using Equation (163–4). ~~The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response $p(k)$.~~

$$SCMR = 20log_{10}\left(\frac{v_{peak}}{V_{CMPP-HF}}\right) \quad (163\text{–}4)$$

where

SCMR	is the signal to AC common-mode ratio in dB
p_{max}	is the maximum value of the differential-mode linear fit pulse response $p(k)$
$V_{CMPP\text{-}HF}$	is the high-frequency peak-to-peak AC common-mode voltage

The high-frequency signal to AC common-mode noise ratio shall meet the specification for *SCMR* (min) in Table 163–5.

v_{peak} is the maximum value of the differential-mode linear fit pulse response p(k) determined using the procedure in 162.9.4.1.1 with equalization off

TX v_peak Comment 4

Cl **163**	*SC* **163.9.2.8**	*P* **207**	*L* **15**	# R1-4

Ran, Adee — Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX V_peak (CC)*

The definition of SCMR uses p_max defined as the maximum of p(k), and the text says "The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response p(k)."

That procedure is applicable for any equalizer setting and will yield different p(k) vectors (it is actually used to characterize the equalization coefficients), so with this definition, SCMR depends on equalization setting. This is not helpful, and not practical to verify.

SCMR (and the limit applied to it) should be defined strictly with respect to the pulse peak in the "no equalization" setting.

Alternatively, we can get remove the SCMR specification and instead specify VCMPP-LF and VCMPP-HF, as on clause 162 and annex 120G. These are defined independently of equalization setting.

SuggestedRemedy

Change the equation to use v_peak instead of p_max, and refer to 162.9.4.1.2 for the definition of v_peak (subject of another comment).

Delete the sentence "The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response p(k)" (it will become redundant).

Proposed Response *Response Status* **W**

PROPOSED REJECT.
This comment does not provide sufficient evidence that v_peak should be used.
For task force discussion.
[Editor's note: CC: 162, 163, 120F]

163.9.2.8 Signal to AC common-mode noise ratio

Signal to AC common-mode noise ratio, *SCMR*, is calculated using Equation (163–4). The procedure in 162.9.4.1.1 is used to determine the differential-mode linear fit pulse response $p(k)$.

$$SCMR = 20\log_{10}\left(\frac{p_{\max}}{V_{CMPP-HF}}\right) \quad (163\text{–}4)$$

where

$SCMR$	is the signal to AC common-mode ratio in dB
$p_{\max}$	is the maximum value of the differential-mode linear fit pulse response $p(k)$
$V_{CMPP-HF}$	is the high-frequency peak-to-peak AC common-mode voltage

The high-frequency signal to AC common-mode noise ratio shall meet the specification for *SCMR* (min) in Table 163–5.

162.9.4.1.2 Steady-state voltage and linear fit pulse peak ratio

The steady-state voltage v_f is defined as the sum of the linear fit pulse $p(1)$ through $p(M \times N_v)$ divided by M, measured with transmit equalizer set to preset 1 (no equalization). N_v is set equal to 200. The linear fit procedure for obtaining p and the values of M and N_p are defined in 162.9.4.1.1. The steady-state voltage shall meet the requirements specified in Table 162–10.

The linear fit pulse peak ratio R_{peak} is defined as the ratio between the maximum value of $p(k)$ and the steady-state voltage v_f.

The linear fit pulse peak ratio shall meet the requirement specified in Table 162–10.

[Editor’s note: SCMR threshold needs to be changed for the suggested remedy?]

TX V_CMPP/SCMR Comment 35

Cl **162** *SC* **162.9.4** *P* **166** *L* **31** # R1-35

Ran, Adee Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX V_CMPP/SCMR (CC)*

(cross-clause - 162 and 120G)
Clause 162 has a specification for V_CMPP-HF directly and not as a ratio of the pulse peak, while clause 163 and annex 120F have the SCMR specification instead.

Since the TP0-TP2 channel can attenuate the both high-frequency common mode noise and the differential signal, the reasoning for using a ratio here is as strong as it is in TP0v. It would be easier for readers to have consistent specification methods.

The SCMR limit for TP2 is suggested based on the limit in Table 163–5, with a relaxation of 1 dB due to possible mode conversion in the longer TP0-TP2 channel.

Applies similarly for clause 120G (at both TP1a and TP4).

SuggestedRemedy

In 162, replace the V_CMPP_HF (max) specification to SCMR (min), pointing to the definition in 163.9.2.8, with a value of 14 dB.

In 120G, apply a similar change, but use 120F.3.1.2 as a reference, and change the reference of VCMPP-LF to 120F.3.1.1 (which have the same 1e-5 probability).

Delete the new content about VCMPP in 120G.5.1.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The comment does not provide evidence to support the proposed changes.
For task force discussion.

Proposed changes:

- Replace $V_{CMPP\text{-}HF}$ with SCMR in 162, 120G
- Change reference in 120G
- Delete V_{CMPP} content in 120G.5.1

120G.5.1 Signal levels

The signal levels are as defined in 120E.3.1.2.

Low-frequency and high-frequency peak-to-peak AC common-mode voltage, $V_{CMPP\text{-}LF}$ and $V_{CMPP\text{-}HF}$, respectively, are defined by the method specified in 163.9.2.7 with the exception that the peak-to-peak AC common-mode voltage is defined as the AC common-mode voltage range measured at TP0v that includes all except 10^{-5} of the measured distribution, from 0.000005 to 0.999995 of the cumulative distribution.

TX V_CMPP/SCMR Comment 42

Cl 162 *SC* 162.9.4 *P* 166 *L* 30 # R1-42

Dawe, Piers J G NVIDIA

Comment Type T *Comment Status* D TX V_CMPP/SCMR (CC)

Now the host has two opportunities to create AC CM and ifg it takes both, it can create much more than in the previous draft. This applies to C2M also.

SuggestedRemedy

Keep the new specs, but reinstate the all-frequencies RMS limit. Also in Table 120G-1.

Proposed Response *Response Status* W

PROPOSED REJECT.
The comment does not provide evidence to demonstrate that the proposed remedy is compatible with the V_CMPP_LF and V_CMPP_HF specs.

CL/AN	D3.1		D3.0
	$V_{CMPP-LF}$ (max)	$V_{CMPP-HF}$ (max)	V_{cmi} (RMS)
162	60 mV	80 mV	30mV
120G Host	60 mV	80 mV	25 mV
120G Module	60 mV	80 mV	25 mV

Note: Spec values for $V_{CMPP-LF}$ and $V_{CMPP-HF}$ may be changed by resolution to comment # 29, 1, 4 or 35.

TX V_CMPP/SCMR
Comment 53

Cl **163** *SC* **163.9.2.7** *P* **207** *L* **4** # R1-53

Dawe, Piers J G NVIDIA

Comment Type **T** *Comment Status* **D** *TX V_CMPP/SCMR (CC)*

The 4th order filter of 93A-20 would work, but it seems a bit fussy, and probably not what noise meters use.

SuggestedRemedy

Use a first order filter or whatever commercial test equipment uses.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
This comment does not provide sufficient evidence for the suggested remedy.
For task force discuss.
[Editor's note: CC: 163, 162, 120F, 120G]

163.9.2.7, p. 207

where

$H_r(f)$ is defined by Equation (93A–20) with f_r set to 100 MHz

802.3dc, D3.2, p. 6708

93A.1.4.1 Receiver noise filter

$H_r(f)$ is a noise filter defined by Equation (93A–20).

$$H_r(f) = \frac{1}{1 - 3.414214(f/f_r)^2 + (f/f_r)^4 + j2.613126(f/f_r - (f/f_r)^3)} \qquad (93A\text{–}20)$$

TX RLM
Comment 30

Cl **162** *SC* **162.9.4.1.1** *P* **167** *L* **6** # R1-30

Ran, Adee Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX RLM (CC)*

(Cross-clause - 162, 163, 120F)

Following ad hoc presentation ran_3ck_01_032322, it is suggested to provide more specific definitions or guidance for Tx parameters that depend on equalization, to enable reasonable test times, both for design (simulations) and qualification (with instruments).

For RLM, the reference is 120D.3.1.2, which does not specify an equalization setting, although RLM can vary between equalization settings. We want high RLM at the setting that is actually used, but for test purposes, the 5 presets should provide sufficient coverage.

SuggestedRemedy

Add a subclause under 162.9.4 with heading "Transmitter linearity" and the following content:
"Transmitter linearity is defined using the method in 120D.3.1.2.
The transmitter linearity shall meet the requirement specified in Table 162–10 when the transmitter equalization is set to any of the initial conditions defined in Table 162-11."

Change the references of RLM in Table 163–5 and Table 120F–1 to point to the new subclause.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
This comment does not apply to the substantive changes between IEEE P802.3ck D3.0 and D3.1 or the unsatisfied negative comments from previous drafts. Hence it is not within the scope of the recirculation ballot.
However, the need to account for equalization effects in the transmitter specifications was addressed in the following presentation, which was reviewed by the task force at a previous ad hoc meeting:
https://www.ieee802.org/3/ck/public/adhoc/mar23_22/ran_3ck_adhoc_01_032322.pdf
For task force discussion.
[Editor's note: CC 120F, 162, 163]

ran_3ck_adhoc_01_032322

RLM

- Nonlinearity in the transmitter after the FFE calculation (e.g. DAC nonlinearity) can degrade the RLM
- How bad is it?
  - In many cases, RLM is improved by applying equalization, since the nominal levels are obtained with a smaller signal.
  - For short channels requiring low equalization, the receiver will likely attenuate the signal via training.

  ⇒ The practical equalization settings will likely improve RLM compared to measurement.
- Still, unspecified equalization is a problem for testing and validation.
- How about: specify SNDR with any of the 5 preset settings defined in Table 162–11.

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120D.3.1.2 Transmitter linearity

Transmitter linearity is defined as a function of the mean signal level transmitted for each PAM4 symbol level. The mean signal levels of the symbols corresponding to the PAM4 symbol levels 0, 1, 2, and 3 are defined as V_0, V_1, V_2, and V_3 respectively, as defined in 120D.3.1.2.1. The mid-range level V_{mid} is defined by Equation (120D–3). The mean signal levels are then normalized and offset adjusted so that V_{mid} corresponds to 0, V_0 to −1, V_1 to $-ES1$, V_2 to $ES2$, and V_3 to 1. $ES1$ is defined by Equation (120D–4) and $ES2$ is defined by Equation (120D–5).

802.3dc D3.2

$$V_{mid} = \frac{V_0 + V_3}{2} \quad (120D\text{–}3)$$

$$ES1 = \frac{V_1 - V_{mid}}{V_0 - V_{mid}} \quad (120D\text{–}4)$$

$$ES2 = \frac{V_2 - V_{mid}}{V_3 - V_{mid}} \quad (120D\text{–}5)$$

The level separation mismatch ratio R_{LM} is defined by Equation (120D–6).

$$R_{LM} = \min((3 \times ES1), (3 \times ES2), (2 - 3 \times ES1), (2 - 3 \times ES2)) \quad (120D\text{–}6)$$

TX SNDR
Comment 31

Cl **162** *SC* **162.9.4.3** *P* **171** *L* **8** # R1-31

Ran, Adee Cisco Systems, Inc.

Comment Type **TR** *Comment Status* **D** *TX SNDR*

(Cross-clause - 162, 163, 120F)

Following ad hoc presentation ran_3ck_01_032322, it is suggested to provide more specific definitions or guidance for Tx parameters that depend on equalization, to enable reasonable test times, both for design (simulations) and qualification (with instruments).

SNDR can depend on equalization setting, but the current definition (reference to 120D.3.1.6) and requirements are generic and can be applied to any equalization setting. We want high SNDR at the setting that is actually used, but for test purposes, the 5 presets should provide sufficient coverage. This would also eliminate unrealistic equalization settings in which the current requirement may be impossible to meet.

The proposed change is on 162.9.4.3, and since 163 and 120F refer back to this subclause it would apply there too.

SuggestedRemedy

Add the following paragraph at the end of 162.9.4.3.:

The transmitter SNDR shall meet the requirement specified in Table 162–10 when the transmitter equalization is set to any of the initial conditions defined in Table 162-11.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
This comment does not apply to the substantive changes between IEEE P802.3ck D3.0 and D3.1 or the unsatisfied negative comments from previous drafts. Hence it is not within the scope of the recirculation ballot.
However, the need to account for equalization effects in the transmitter specifications was reviewed in the following presentation, which was reviewed by the task force in a previous ad hoc meeting:
https://www.ieee802.org/3/ck/public/adhoc/mar23_22/ran_3ck_adhoc_01_032322.pdf.
For task force discussion.
[Editor's note: CC 120F, 163]

Table 162–11—Coefficient initial conditions

Coefficient update state	ic_req	$c(-3)$	$c(-2)$	$c(-1)$	$c(0)$	$c(1)$
OUT_OF_SYNC[a]	N/A	0	0	0	1	0
NEW_IC	preset 1[a]	0	0	0	1	0
	preset 2	0 ± 0.0125	0 ± 0.0125	0 ± 0.0125	0.5 ± 0.0125	0 ± 0.0125
	preset 3	0 ± 0.0125	0 ± 0.0125	–0.075 ± 0.0125	0.75 ± 0.0125	0 ± 0.0125
	preset 4	0 ± 0.0125	0.05 ± 0.0125	–0.2 ± 0.0125	0.75 ± 0.0125	0 ± 0.0125
	preset 5	–0.025 ± 0.0125	0.075 ± 0.0125	–0.25 ± 0.0125	0.65 ± 0.0125	0 ± 0.0125

[a]PRESET1 is the reference for the calculation of the normalized coefficients of the transmit equalizer (see 162.9.3.1.1). As a result the normalized coefficients for PRESET1 and OUT_OF_SYNC do not include any tolerances.

Host ILdd, TX R_peak Comments 41, 43

Cl **162A** *SC* **162A.4** *P* **285** *L* **1** # R1-41

Dawe, Piers J G NVIDIA

Comment Type **T** *Comment Status* **D** *channel equations*

The equation for the channel from TP0 to TP2 or from TP3 to TP5 including the test fixture should be checked for consistency with the equations for the PCB, the mated test fixtures, and the cable test fixture traces, although there won't be a perfect match because of the allowances for ball grid array (BGA) footprint and host connector footprints, as well as the difference between product connector and test fixture connector.

SuggestedRemedy

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The following related presentation was provided for review by the task force:
https://www.ieee802.org/3/ck/public/22_04/dawe_3ck_02_0422.pdf
The comment is written as request for work to be done and does not include an actionable remedy.

Cl **162** *SC* **162.9.4** *P* **166** *L* **40** # R1-43

Dawe, Piers J G NVIDIA

Comment Type **TR** *Comment Status* **D** *TX V_peak (CC)*

The revision to the mated test fixtures' reference loss to be more like real measurements makes a small difference to the expected Rpeak.

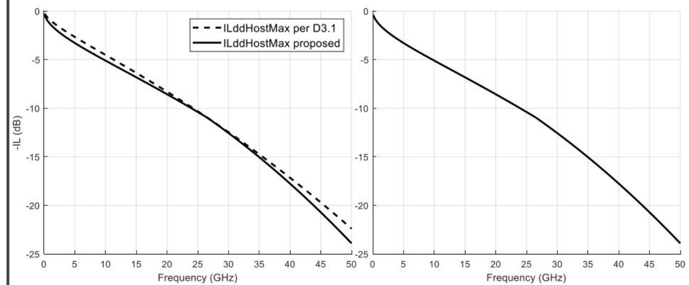
SuggestedRemedy

Reduce Rpeak (min) by 1% from 0.397 to 0.393. ← 0.36

Proposed Response *Response Status* **W**

PROPOSED REJECT.
This comment does not apply to the substantive changes between IEEE P802.3ck D3.0 and D3.1 or the unsatisfied negative comments from previous drafts. Hence it is not within the scope of the recirculation ballot.
The following related presentation was provided for review by the task force:
https://www.ieee802.org/3/ck/public/22_04/dawe_3ck_02_0422.pdf
The comment does not provide evidence to support the proposed remedy.

Summary, new plot for Fig 162A–2



- Figure 162A–2 Insertion loss from TP0 to TP2 or from TP3 to TP5

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Associated changes

- Equation 162A–3
  - Existing: $ILdd_{Host} \le ILdd_{HostMax}$ =
  - 1.5658*(0.471*sqrt(f) + 0.1194f + 0.002f^2)
  - Proposed: $ILdd_{Host} \le ILdd_{HostMax}$ =
  - 1.2513*sqrt(f) + 0.08007f + 0.003405f^2 0.01 <= f <= 26.56
  - 1.1351*sqrt(f) + 0.05202f + 0.005310f^2 26.56 < f <= 50
- Recalculate *Rpeak* (min) based on the magenta line
  - Table 162-10
  - ISI affects *Rpeak* too, so can't use the smooth curves: have to go back to more realistic models with ISI
  - Existing: 0.397
  - Proposed: 0.36

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dawe_3ck_02a_0422